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Holzgrefe

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[54] **INJECTION VALVE FOR FUEL INJECTION SYSTEMS**

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[51] **Int. Cl.**[5] **F02M 61/20**

[52] **U.S. Cl.** **239/491**; 239/585

[58] **Field of Search** 239/600, 585, 473, 482, 239/483, 584, 490, 491, 533.3–533.12, 463

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[57] **ABSTRACT**

An injection valve for fuel injection systems of internal combustion engines which is used for injection of fuel into the intake tube. The injection valve includes a valve housing in which a core that cooperates with an armature is located. Connected to the valve housing is a nozzle body in which a conical valve seat face is formed, with which a sealing section of a valve needle actuated by the armature cooperates. The valve needle is guided by guide sections in a guide bore of the nozzle body, and upstream of the sealing section, the valve needle has a cylindrical section which protrudes through a central opening of an insert body. The insert body rests with a jacket sealing face on the valve seat face and has flow openings that lead from upstream to downstream of the insert body and are aimed at the valve seat face.

17 Claims, 2 Drawing Sheets

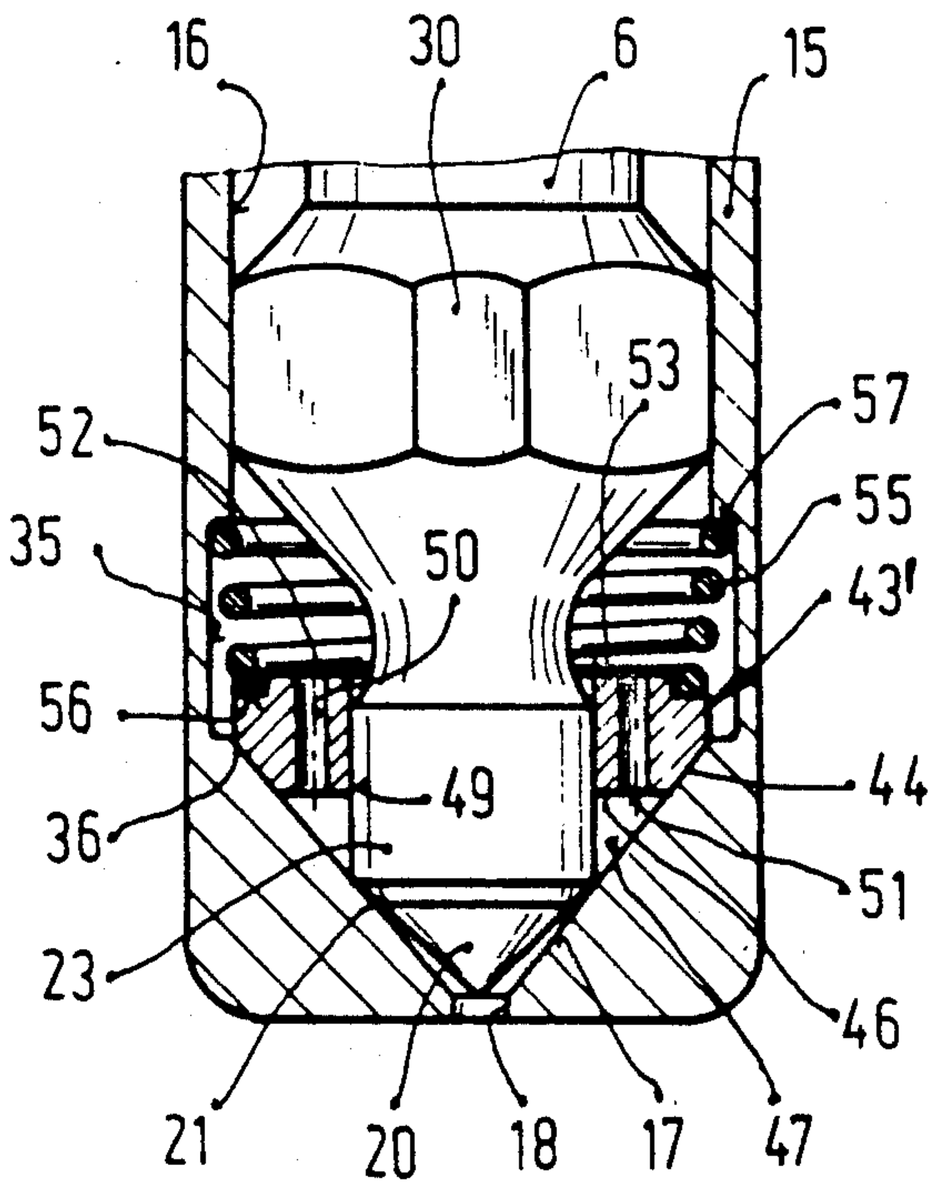

Fig.1

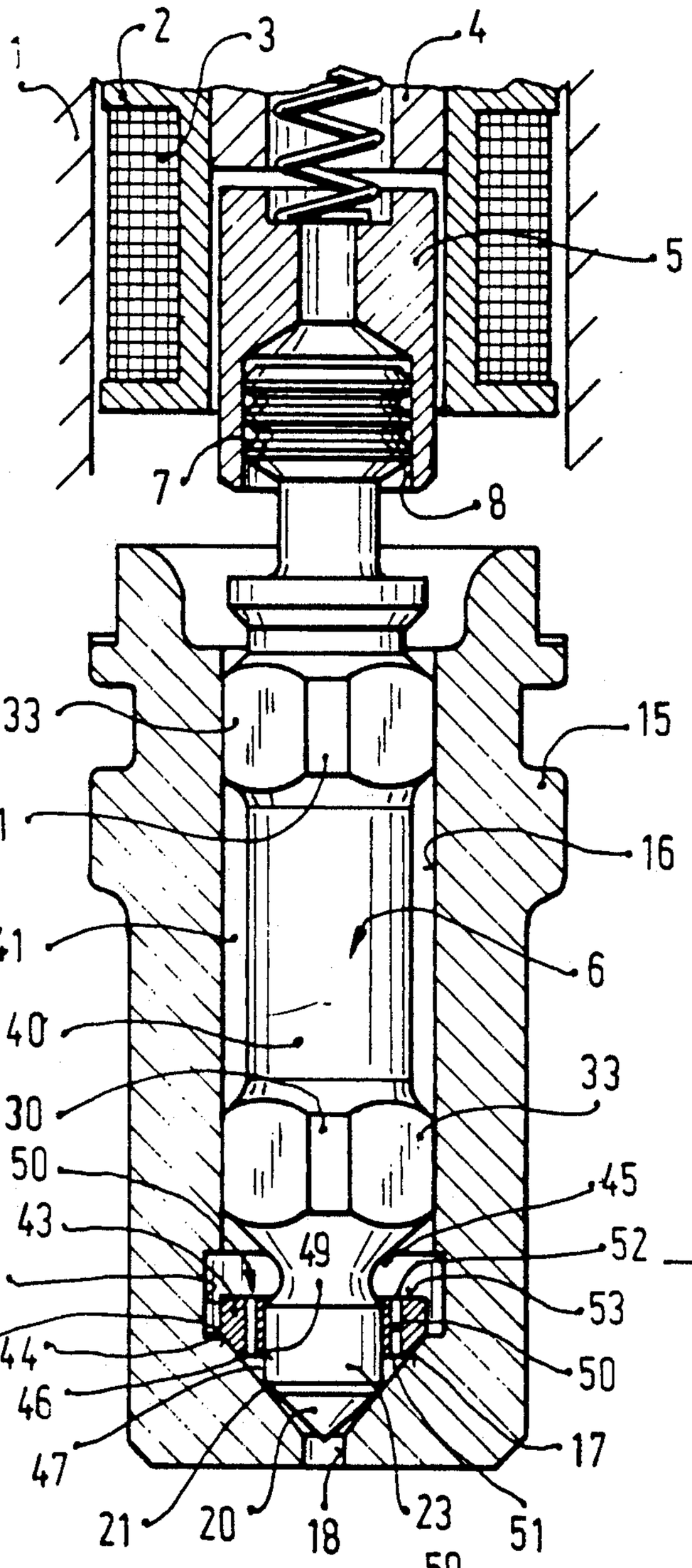
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Fig.2

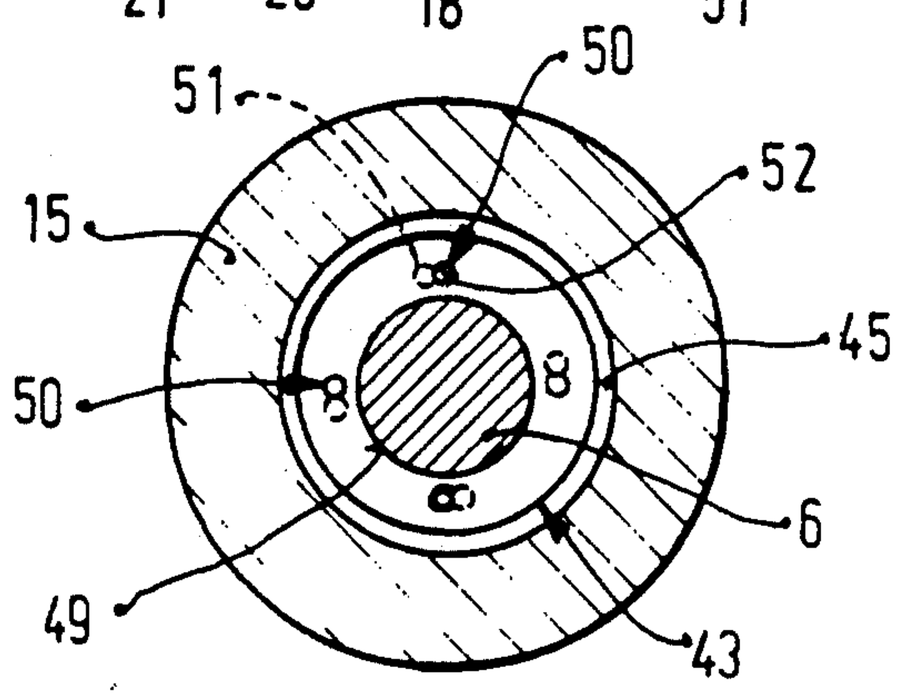
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Fig.3

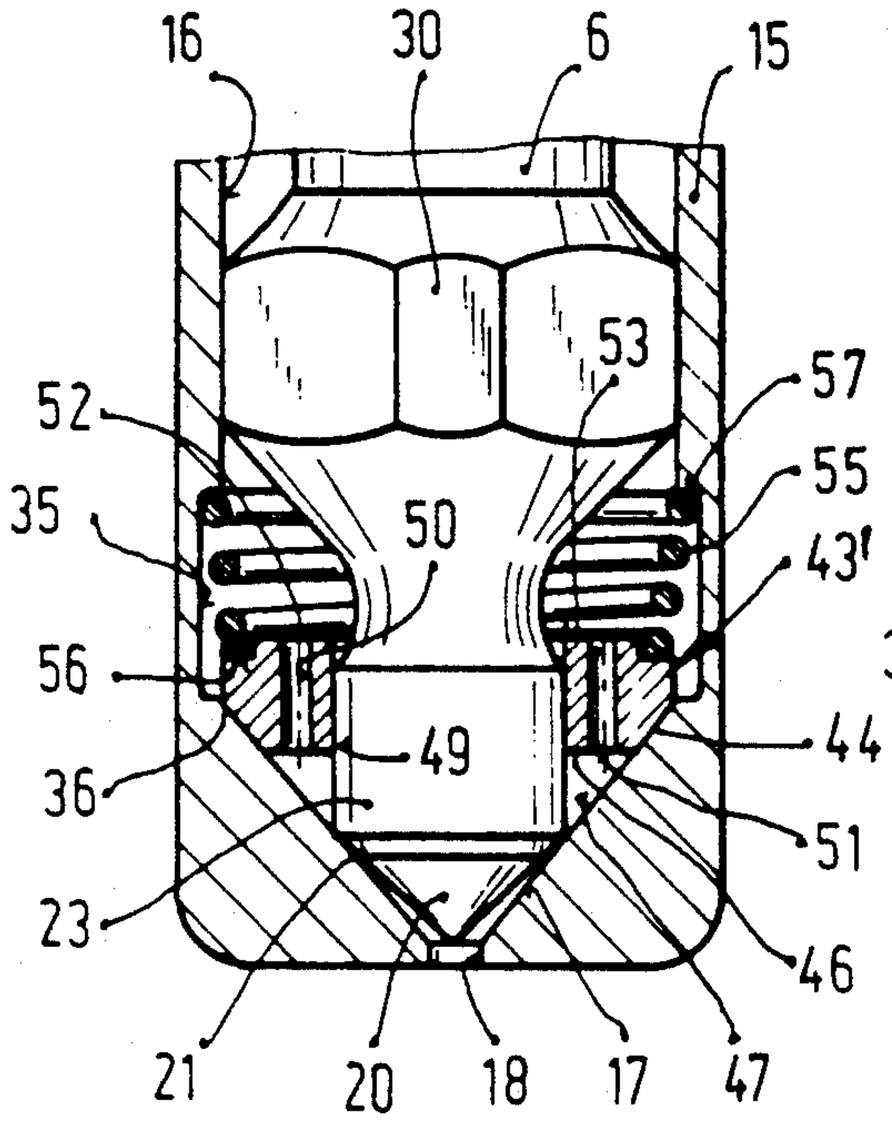
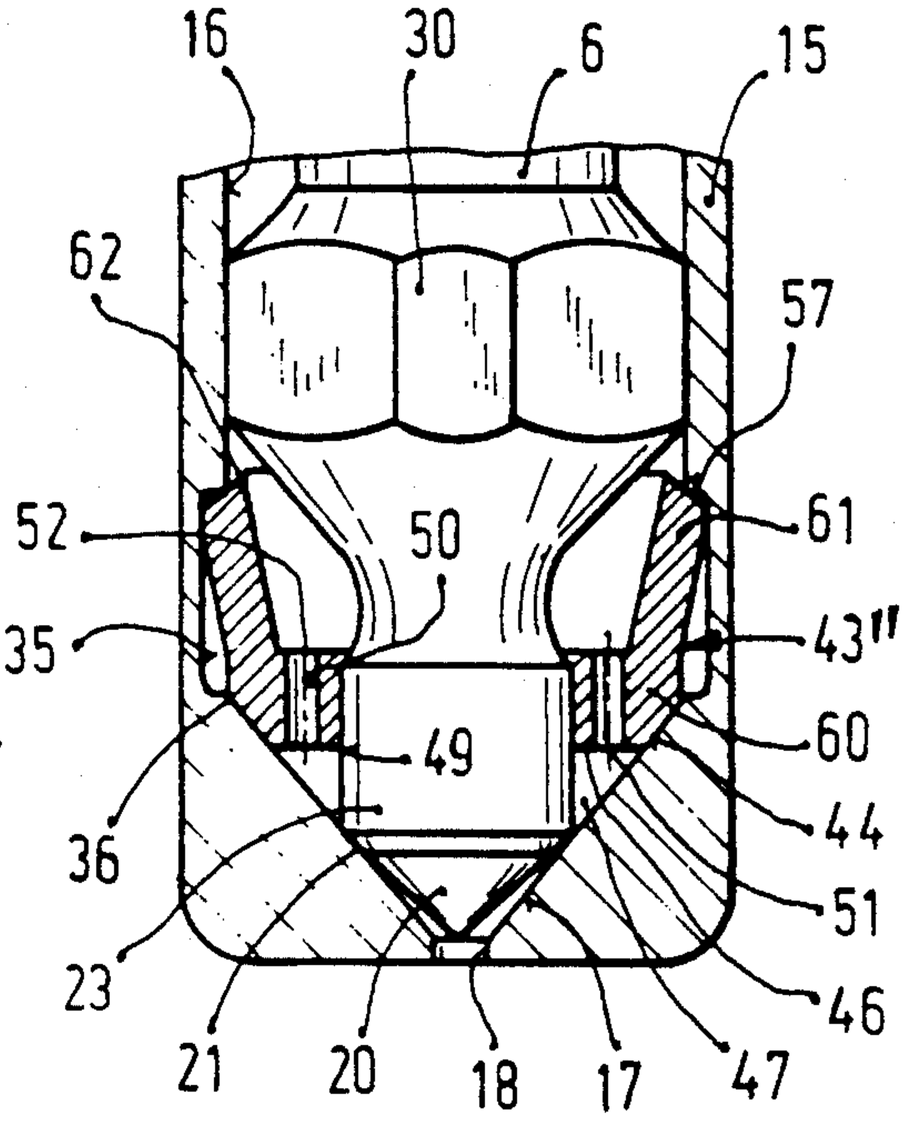


Fig.4



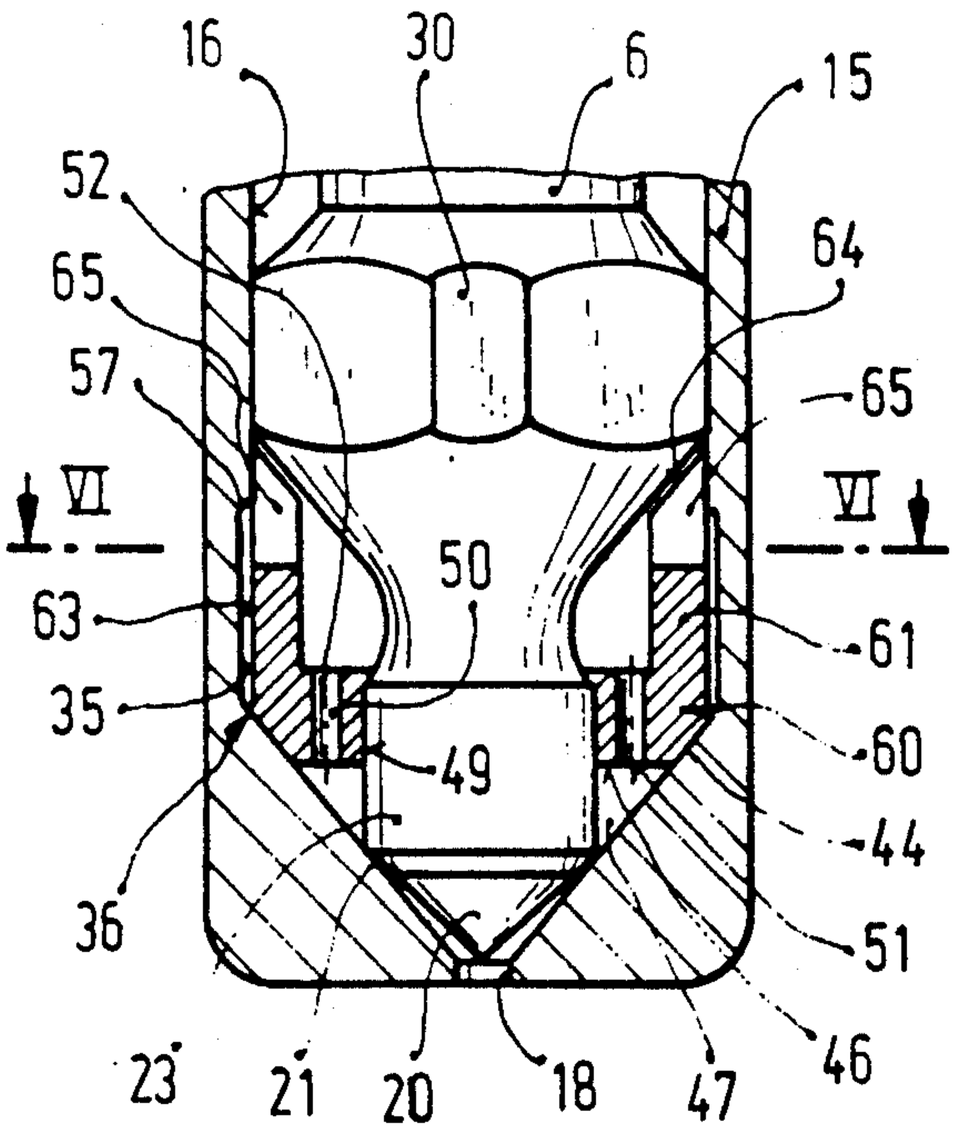


Fig.5

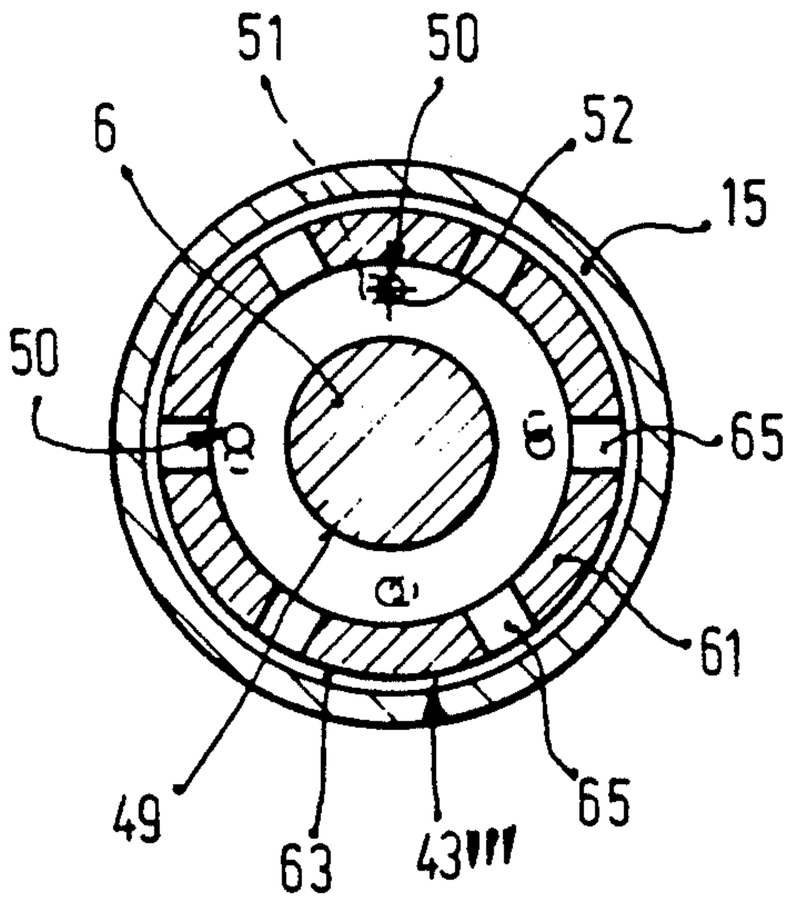


Fig. 6

INJECTION VALVE FOR FUEL INJECTION SYSTEMS

BACKGROUND OF THE INVENTION

The invention is based on an injection valve as defined hereinafter. An injection valve is already known in which flow openings extend in an insert body such that the fuel streams emerging from them are aimed at the valve needle. As a result, the fuel must first be deflected toward the valve seat face, causing flow losses that reduce the energy available for fuel preparation.

An injection valve is also known in which to improve the sprayed fuel stream, swirl grooves are provided upstream of the valve seat, extending parallel to the longitudinal axis of the valve, which serve to make the fuel turbulent even before it flows through the valve seat. These swirl grooves impose a tangential force component upon the fuel emerging from the spray opening, causing the fuel to be ejected in a conical spray pattern. This inherently favorable effect can be only partly exploited in this known injection valve, however, because after emerging from the swirl grooves, which are machined into the circumference of the valve needle, the fuel flows into the vicinity of the undercut (which is required for manufacturing reasons), where it is slowed down severely. A further disadvantage of this known injection valve is that the metering of the fuel quantity injected per unit of time is determined, in such an injection valve, by the size of the flow cross section of the spray opening downstream of the valve seat with the valve opened. As a result, over relatively long operation the deposits that unavoidably form during use can reduce the cross section, hence leading to reduced flow-through quantities. This phenomenon of "leaning down" is feared. It also arises with other embodiments of the metering zone, as long as such a zone is located downstream of the valve seat and hence is exposed to the atmosphere of the intake tube.

Another known injection valve, by comparison, offers the advantage that the quantity of fuel to be sprayed is metered upstream of the valve seat. To this end, metering bores are provided in the lower guide section of the valve needle, by way of which bores the fuel flows with a pressure drop. No provisions are apparent for generating any swirl in the fuel, however. Furthermore, the disposition of the metering bores on the valve needle is disadvantageous from a manufacturing standpoint because it also requires machining of the high-quality valve needle material. For atomizing the fuel, there is a needle pintle located inside the spray opening.

OBJECT AND SUMMARY OF THE INVENTION

The injection valve according to the invention has an advantage over the prior art of improving known injection valves in a simple fashion such that, without directly changing their construction and using easily machined materials, it becomes possible to generate a fuel swirl and to perform fuel metering upstream of the valve seat face. The improved valve includes an insert body having flow openings through which the fuel emerges from the flow openings flows through the valve seat and the spray opening without braking, with high kinetic energy, so that high-speed flow impact and very good fuel preparation are attained.

It is advantageous for the insert body to be elongated, to avoid its assuming a tilted position. It may also be

advantage for the insert body to be fixed in the axial direction.

The invention will be better understood and further objects and advantages thereof will become more apparent from the ensuing detailed description of preferred embodiments taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a section taken through a first exemplary embodiment of an injection valve;

FIG. **2** is a section taken along the line II—II of FIG. **1**;

FIG. **3** is a fragmentary view of a second exemplary embodiment of an injection valve;

FIG. **4** is a fragmentary view of a third exemplary embodiment of an injection valve;

FIG. **5** is a fragmentary view of a fourth exemplary embodiment of an injection valve; and

FIG. **6** is a section taken along the line VI—VI of FIG. **5**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows a valve housing **1** of an injection valve, not shown in further detail, for fuel injection systems of mixture-compressing internal combustion engines having externally supplied ignition. Located inside this valve housing **1** is a magnet coil **3** mounted on a coil holder **2**. A ferromagnetic core **4** is located inside the coil holder **2**, partly surrounded by the magnet coil **3**. An armature **5** is also located partly inside the coil holder **2**, oriented toward one face end of the core **4**, and is fixedly connected to a valve needle **6**, which in turn is fitted with one end **7** into a recess **8** of the armature **5**. The valve needle **6** is displaceably supported in a nozzle body **15**, which is connected in a known manner not shown with the valve housing **1**. The nozzle body **15** has a coaxial guide bore **16**, which is adjoined in the direction remote from the magnet coil **3** by a conically tapering valve seat face **17**, which in turn terminates in a spray opening **18**. The valve needle **6** is guided in the guide bore **16** of the nozzle body **15**, and in the direction remote from the magnet coil **3** this valve needle terminates in a conical end section **20**, which adjoins a cylindrical section **23** by a narrow sealing section **21**. When the injection valve is closed, this sealing section **21** rests directly on the conical tapering valve seat face **17** of the nozzle body **15**. To open the injection valve, the valve needle **6**, with this sealing section **21**, lifts away from the valve seat face **17** and thus opens up a flow opening for the fuel. The conical end section **20** may still protrude partway with its tip into the spray opening **18**. Also, the conical section may as shown terminate in a cone, or it may have a needle pintle, which forms a coaxial prolongation of the valve needle **6** and may protrude from the spray opening **18** of the nozzle body **15**.

The valve needle **6** also has, adjoining the sealing section **21**, a cylindrical section **23**, and adjoining that are two axially spaced guide sections **30** and **31** which provide guidance for the valve needle **6** inside the guide bore **16**. On their perimeter, the guide sections **30**, **31** form in conjunction with the bore **16** flow openings **33**, which may for example be embodied as faces, so that the flow openings are generally in the form of squares, or rectangles, for example formed between cylindrical portions which form the guide sections **30**, **31**.

The guide bore **16** of the nozzle body **15** that receives the guide sections **30** and **31** is stepped, in the direction remote from the magnet coil **3** near the valve seat face **17**, in the form of an enlargement **35** dictated by manufacturing considerations. The diameter of the enlargement **35**, which may also be called an "undercut", is greater than the diameter of the guide bore **16**. The enlargement **35** is adjoined by the aforementioned valve seat face **17** with its base diameter **36**.

Between the guide sections **30** and **31**, the valve needle **6** has a connecting section **40** of reduced diameter as compared with these guide sections; in the radial direction, along with the guide bore **16**, the guide sections **30**, **31** and the connecting section **40** define an annular flow conduit **41**.

According to the invention, an annular insert body **43** is introduced into the guide bore **16**, resting with a conical jacket sealing face **44** on the valve seat face **17** and thus dividing an upper chamber **45**, formed between the guide section **30** and the insert body **43**, from a lower chamber **47** defined by the cylindrical section **23**, the valve seat face **17** and the lower end face **46** of the insert body **43**. The cylindrical section **23** of the valve needle **6** protrudes with little play through a central opening **49** of the insert body **43**. The insert body **43** is penetrated by at least one flow opening **50**. As shown in FIG. **2**, in the present exemplary embodiment there are four flow openings **50**, at which when the sealing section **21** is raised from the valve seat face **17** the fuel flowing through from the upper chamber **45** to the lower chamber **47** undergoes a pressure drop of for instance approximately 20% of the pressure difference that is available between the upper chamber **45** and the spray opening **18**. The flow openings **50** can accordingly more or less serve the purpose of fuel metering. The openings **51** of the flow openings **50** discharge into the lower chamber **47** with the fuel aimed at the valve seat face **17**, so that the fuel streams emerging from the discharge openings strike the valve seat face **17** directly, without being deflected. The flow openings **50** may advantageously have an inclined course relative to the longitudinal axis of the valve, so as to generate a swirl; the inclination of the flow openings **50** may also extend either such that the discharge openings **51** are spaced more closely apart radially from the cylindrical section **23** of the valve needle **6** than the inlet openings **52** of the flow openings **50**, or such that a tangential component is imparted to the fuel streams, as shown in FIG. **2**. As a result of the different fuel pressure forces on its upper end face **53** and its lower end face **46**, the inset body **43** is pressed with its jacket sealing face **44** against the valve seat face **17**, making further sealing at the circumference unnecessary. Because there is little play between the cylindrical section **23** and the central opening **49** of the insert body **43**, there is only a slight constant leakage flow. Stringent demands are not placed on the material comprising the insert body **43**, so that a less-expensive, easily machined material can be used for this part.

In the second exemplary embodiment of the invention shown in FIG. **3**, elements remaining the same as and functioning like those of FIGS. **1** and **2** are identified by the same reference numerals. In contrast to the exemplary embodiment of FIGS. **1** and **2**, in the second exemplary embodiment of FIG. **3** the insert body **43'** is no longer loosely movably disposed in the nozzle body **15** but instead is urged toward the valve seat face **17** by a spring **55**, which engages a step **56** on the upper end face **53** of the insert body **43** and on its other end is braced against a shoulder **57** in the nozzle body **15** that is formed between the guide bore **16** and the enlargement **35**. The disposition of the spring **55** makes it possible to prevent possibly excessive axial movements by the insert body **43'** during rough vehicle operation. The spring shown in FIG. **3** is embodied as a conical spring, by way of example, but some other spring shape can also be used to attain the spring force.

In the exemplary embodiment of an injection valve according to the invention shown in FIG. **4**, elements identical to and functioning like those of the foregoing embodiments are again identified by the same reference numerals, and these elements that have already been described need not be described again here. In the third exemplary embodiment in FIG. **4**, the insert body **43''** is cup-shaped and has a bottom portion **60** oriented toward the valve seat face **17** and an annular rim **61** oriented toward the guide section **30**. The jacket sealing face **44** that cooperates with the valve seat face **17** is formed on the bottom portion **60**, remote from the annular rim **61**. The central opening **49** and the flow opening **49** and the flow openings **50** also penetrate the bottom in the manner described above. After the insertion of the insert body **43''** into the nozzle body **15**, the annular rim **61** is bent radially outward in such a way that with its rim end face **62** oriented toward the guide section **30** it comes to rest on the shoulder **57**, so that the jacket sealing face **44** is pressed sealingly against the valve seat face **17**, and the insert body **43** remains fixed in this position during use even when jarred.

In the fourth exemplary embodiment of the invention shown in FIGS. **5** and **6**, once again elements identical to and functioning like those of the foregoing embodiments are identified by the same reference numerals. In the exemplary embodiment of FIGS. **5** and **6**, the insert body **43''** is cup-shaped as in the embodiment of FIG. **4**, having a bottom portion **60** and an annular rim **61**, but in this case it is embodied so that in the direction toward the guide section **30** it rests with little play on the guide bore **16**, preventing tilting of the insert body **43** relative to the valve needle **6**. The jacket **63** of the annular rim **61** thus extends cylindrically. The rim end face **64** oriented toward the guide section **30** is preferably oblique, corresponding to the course of the valve needle **6** in this region. Through openings **65** that are open toward the rim end face **64** penetrate the annular rim **61** and serve to guide fuel from the guide section **30** to the flow openings **50**; in this exemplary embodiment, six through openings **65** are provided, distributed uniformly over the circumference.

As in the exemplary embodiment of FIGS. **1** and **2**, the insert body **43'''** of the exemplary embodiment of FIGS. **5** and **6** is again disposed loosely in the axial direction in the nozzle body **15** and is acted upon in a sealing fashion, in the direction toward the valve seat face **17**, solely by the various fuel pressures.

The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. An injection valve for fuel injection systems of internal combustion engines, comprising a nozzle body, a conical valve seat face that tapers conically from a cylindrical base diameter, an axial spray opening in said

nozzle body adjoining the valve seat face, a valve needle which has a sealing section (21) cooperating with a first portion of the valve seat face and a cylindrical section (23) upstream from and adjoining said sealing section and at least one guide section that with its circumference guides the valve needle in a guide bore of the nozzle body (15), an annular insert body (43) is arranged downstream of said at least one guide section juxtaposed and surrounding said cylindrical section of said valve needle, said annular insert body having at least one flow opening extending from upstream to downstream of the insert body, said insert body including a jacket sealing face which seals against a second portion of said conical valve seat face between said sealing section and said at least one guide section of said valve needle, said valve needle includes a cylindrical section which protrudes with little play through a central opening of said insert body and said at least one flow opening in said annular insert body is aimed at a third portion of said valve seat face upstream of said first portion arranged to cooperate with the sealing section of the valve needle.

2. An injection valve as defined by claim 1, in which said insert body is engaged on one end by a spring (55) that urges said insert body in a direction toward said second portion of said valve seat face (17).

3. An injection valve as defined by claim 1, characterized in that upstream of the valve seat face (17), the guide bore (16) has a shoulder (57), on which an annular rim (61) of the insert body (43) is supported.

4. An injection valve as defined by claim 1, in which said jacket sealing face (44) of said insert body extends at approximately the same angle as said valve seat face (17) and rests thereon.

5. An injection valve as defined by claim 1, in which there are more than one flow opening and each flow opening (50) extends in an inclined manner with respect to the guide bore (16), in order to generate a swirl.

6. An injection valve as defined by claim 1, in which said at least one flow opening (50) is used for fuel metering.

7. An injection valve as defined in claim 5, wherein each of said flow openings is used for fuel metering.

8. An insert body for use in an injection valve for an internal combustion engine which comprises

a central axial bore through which an end portion of a valve needle passes,

a plurality of equally spaced openings which extend from upstream to downstream through said insert body through which fuel flows, and

said insert body further includes a bottom portion and an upwardly extending rim.

9. An insert as set forth in claim 8, in which,

said plurality of equally spaced openings slope at an angle relative to a vertical plane through a longitudinal axis which cuts an upper end of said opening.

10. An insert as set forth in claim 8, in which said upwardly extending rim further includes an outwardly flared annular portion.

11. An injection valve for fuel injection systems of internal combustion engines, comprising a nozzle body, a conical valve seat face that tapers conically from a cylindrical base diameter, an axial spray opening in said nozzle body adjoining the valve seat face, a valve needle which has a sealing section cooperating with a first portion of the valve seat face and a cylindrical section upstream from and adjoining said sealing section and at least one guide section that has a perimeter that includes flow openings, and cylindrical portions that guide the valve needle in a guide bore of the nozzle body (15), an annular cup-shaped insert body (43) is arranged downstream of said at least one guide section juxtaposed and surrounding said cylindrical section of said valve needle, said annular cup-shaped insert body includes a bottom portion (60) oriented toward said valve seat face, at least one flow opening extending from upstream to downstream of said bottom portion of said cup-shaped insert body, said cup-shaped insert body including an annular rim (61) oriented toward said at least one guide section (30) of said valve needle (6), a jacket sealing face which seals against a second portion of said conical valve seat face between said sealing section and said at least one guide section of said valve needle, said valve needle includes a cylindrical section which protrudes with little play through a central opening (49) of said cup-shaped insert body and said at least one flow opening in said annular cup-shaped insert body is aimed at a third portion of said valve seat face upstream of the portion arranged to cooperate with the sealing section of the valve needle.

12. An insert as set forth in claim 11, in which,

said at least one opening slopes at an angle relative to a vertical plane through a longitudinal axis which cuts an upper end of said opening.

13. An injection valve as defined by claim 11, in which at least one radial through opening (65) is provided in said annular rim (61).

14. An insert body for use in an injection valve for an internal combustion engine which comprises;

a bottom portion and an upwardly extending rim,

a central axial bore through said bottom portion through which an end portion of a valve needle passes,

a plurality of equally spaced openings which extend from upstream to downstream through said bottom portion of said insert body through which fuel flows, and

said upwardly extending rim is provided with through openings which are distributed uniformly over the circumference thereof.

15. An insert as set forth in claim 14, in which,

each of said plurality of equally spaced openings slope at an angle relative to a vertical plane through a longitudinal axis which cuts an upper end of said opening.

16. An insert body in combination with a spring for assembly in a central bore in an injection valve for an internal combustion engine through which an end portion of a valve needle passes to seat upon a conical valve seat, in which;

said insert body includes a plurality of equally spaced openings which extend from upstream to downstream through said insert body through which fuel flows, and

said spring means is positioned within said central bore relative to said insert body to urge said insert body against a portion of said valve seat face of said injection valve to seat thereon.

17. An injection valve as defined by claim 11, in which said insert body is engaged on one end by a spring (55) that urges said insert body in a direction toward said second portion of said valve seat face (17).

* * * * *